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ABSTRACT

The Position Analysis Questionnaire (PAQ) is a job analysis instrument consisting of 187 job elements organized into six divisions. The PAQ was used in the eight studies summarized in this final report. The studies were: (1) ratings of the attribute requirements of PAQ job elements, (2) a series of principal components analyses of these attribute profiles, (3) derivation of job dimensions, (4) job component validity based on PAQ data, (5) job component method for establishing compensation rates, (6) the analysis of rates of naval compensation, (7) job and personal factors as related to job satisfaction, and (8) the development of job clusters based on the BC-TRY and CODAP procedures. The report provides information on rating procedures, methods of analysis, results, sample of jobs, sample of naval billets, and discussion where relevant. (AG)

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The Application of Structured Job Analysis Information Based on the Position Analysis Questionnaire (PAQ)

ERNEST J. McCORMICK

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THE APPLICATION OF STRUCTURED JOB ANALYSIS INFORMATION BASED ON THE POSITION ANALYSIS QUESTIONNAIRE (PAQ)

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This report is the final report based on the contract referred to above. In large part it is a summary of the several studies that have been carried out under the provisions of this contract. All of these studies have involved the use of a structured job analysis procedure called the Position Analysis Questionnaire (PAQ). This job analysis instrument consists of 187 job elements organized into six divisions. In the analysis of a job with the PAQ the relevance of the individual elements to the job are rated

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using any of several rating scales such as importance, time, etc.

The several studies carried out included the following:

1. The rating of the relevance to the individual job elements of the PAQ of each of 76 attributes, this resulting in an attribute profile for each of the job elements.
2. A series of principle components analyses of these attribute profiles.
3. A series of principle components analyses of data for a sample of 3700 jobs, this resulting in the identification of 30 "divisional" job dimensions, and 14 "general" (G) job dimensions.
4. The use of data based on the PAQ in the context of job component validity (that is, the statictial estimation of aptitude requirements for jobs on the basis of job analysis data).
5. The use of data based on teh PAQ for the estimation of compensation rates of jobs.
6. The use of a special Navy version of the PAQ for the analysis of compensation relevant to enlisted billets on three aircraft carriers and in air squadrons (in particular, a comparison was made of the relationship between the compensation for enlisted personnel as compared with the compensation that would be appropriate for jobs in the civilian labor market with corresponding characteristics).
7. The development of job clusters based on 2 clustering procedures (the BC-TRY and the CODAP procedures).
8. The analysis of the relationship between job characteristics, personal interests, and response dispositions of individuals as related to job satisfaction (this study being carried out with jobs and job incumbents in the telephone industry).

In general terms, the results of these several studies lend further support for the use of data from structured job analysis procedures for various personnel-related objectives.

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INTRODUCTION

The research carried out under the provisions of this contract represents a continuation of a research program dealing with the development of a structured job analysis procedure, and the application of data based on such a procedure in certain specific contexts. This particular report consists of a recapitulation and summary of the several technical reports that have been based on the various phases of the program.

The Rationale for Structured Job Analysis Procedures

Structured job analysis procedures provide for the analysis of various jobs in terms of each of a number of "units" of job-related information. Such procedures typically provide for the analysis of any given job in terms of the relevance of each of the "units" in question, the analysis usually being in terms of either a dichotomous response (such as whether the item does or does not apply to the job), or by the use of a rating scale indicating the relative extent to which the item does apply.

There are of course many different "classes" of job-related information that can be used in structured job analysis procedures. In this regard, McCormick (1959) differentiates between what are referred to as "job-oriented" versus "worker-oriented" elements. Job-oriented elements tend to characterize job activities in terms of what a worker accomplishes in a job, expressed in terms that are relevant to the technology or processes of the job in question, such as operating a sewing machine, repairing refrigerators, grinding castings, etc. On the other hand, worker-oriented job elements tend to characterize the human behaviors that are involved in job activities, such as the nature of the sensory, perceptual, mediation, and physical activities involved in jobs. For certain operational or research purposes the use of a structured job analysis procedure that provides for characterizing the job-oriented activities of jobs would be most relevant. The most extensive work along these lines has been the development and use of task inventories by the United States Air Force. On the other hand, for other purposes, structured job analysis procedures based on the use of worker-oriented activities would be more appropriate, especially for reflecting the similarities and differences between and among jobs of different technologies in terms of various types of human behaviors. If there would be any similarities between and among the jobs of the butcher, the baker, and the candlestick maker, these would be revealed by the use of a job analysis procedure based on the use of worker-oriented job elements.

The rationale for the use of structured job analysis procedures, of these or other types, lies primarily in the fact that such procedures can provide for the quantification of job-related data. In turn, it is reasonable to expect that quantified job-related data could serve a number of potentially practical purposes.

The Position Analysis Questionnaire (PAQ)

Form B of the Position Analysis Questionnaire (PAQ) is a structured job analysis procedure consisting of 187 job elements of a worker-oriented nature. The previous form of the PAQ, Form A, has been used in a previous research project (McCormick, Jeanneret, and Mecham, Report No. 6, June 1969). The present study involved the use of Form B of the PAQ, which had been developed as a part of the previous project.

The PAQ was developed in part to parallel the conventional S-O-R (stimulus-organism-response) model of human activity, which is predicated on the concept of a stimulus acting upon an organism to bring about a response. In terms of the activities involved in jobs, these three aspects of human behavior can be viewed as information-input, mediation, and work output. The PAQ includes job elements dealing with each of these three, and in addition includes elements dealing with interpersonal relationships, with the work context, and with miscellaneous characteristics. Following is a list of the divisions of the PAQ with a couple of examples of job elements within each.

Division of PAQ	Examples of job elements
1. Information Input	Use of written materials Near-visual differentiation
2. Mental Processes	Level of reasoning in problem solving Coding/decoding
3. Work Output	Use of keyboard devices Assembling/disassembling
4. Relationships with Other Persons	Negotiation Job-related personal contact
5. Job Context	High temperature Interpersonal conflict situations
6. Other Job Characteristics	Specified work pace Amount of job structure

Various types of rating scales are provided for use in analyzing jobs with the job elements. These include such scales as "Importance," "Extent of use," "Time," etc. Most of the rating scales are five-point scales ranging from "0" (does not apply) to "5" (the highest scale value). Certain items are analyzed by the use of a dichotomous scale (such as "does not apply," or "does apply").

Previous Areas of Research with the Position Analysis Questionnaire

In general terms, the previous research with the PAQ was directed toward two objectives, namely those of possible use of PAQ-based data as the basis for the establishment of aptitude requirements of jobs, and for use in the establishment of compensation rates for jobs. Since previous studies are reported elsewhere they will not be reviewed here. (Readers are referred to the following sources: Mecham and McCormick, Report No. 1, Jan. 1969; Jeanneret and McCormick, Report No. 2, June 1969; Mecham and McCormick, Report No. 3, June 1969; Mecham and McCormick, Report No. 4, June 1969; McCormick, Jeanneret and Mecham Report No. 5, June 1969; McCormick, Jeanneret, and Mecham, Report No. 6, June 1969; and McCormick, Jeanneret and Mecham, 1972).

RATINGS OF THE ATTRIBUTE REQUIREMENTS OF PAQ JOB ELEMENTS[1]

For certain purposes relevant to a couple of the later studies to be reported, arrangements were made for obtaining ratings of the "attribute requirements" of the job elements of the PAQ. As a construct, an "attribute" is somewhat akin to the concept of a human "trait" or quality." Some of the attributes used in this phase of the study characterized what are commonly thought of as aptitudes, such as arithmetic reasoning, intelligence, and finger dexterity. Others dealt with various types of "situations" and can be considered in terms of the requirement for the individual to "adapt" to the situation. Some examples include: variety of duties; dealing with people; working alone; and pressure of time. Ratings of the attribute requirements for 68 such attributes had been obtained as related to the job elements of Form A of the PAQ by Mecham and McCormick (Report No. 1, Jan. 1969). In the present study ratings were obtained for the job elements of Form B of the PAQ that were new or different from those included in Form A, and, in addition, ratings of the relevance of eight additional attributes were obtained, making a total of 76 such attributes (Marquardt and McCormick, Report No. 2, 1974).

Raters

Most of the raters were psychologists, especially those from Division 14 of the American Psychological Association (Division of Industrial and Organizational Psychology). Considering the combined set of ratings obtained from the previous study and the present study, the relevance of the individual attributes to the job elements were rated by at least 8 but not more than 18 raters.

Rating Procedures

Each rater was asked to rate the relevance of anywhere from one to three individual attributes to the job elements in the PAQ. In particular, they were asked to rate on a six-point scale (0-5) how

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[1] This section is based largely on a report by Marquardt and McCormick (Report No. 1, June 1972).

relevant, important, or applicable the attribute being rated was to each job element in the PAQ. They were instructed to consider each PAQ job element as though it were very important in a (hypothetical) job.

Derivation of Attribute Profiles

For each of the job elements the median value of the several ratings for each attribute was derived. Thus, for that job element there would be a median rating on each of the 76 attributes. This set of medians was considered to comprise the "attribute profile" for the job element in question. The median values were used to characterize the attribute profiles, rather than the means, in order to minimize the possible effects of occasional extreme ratings. As a matter of interest, however, the correlation between the means and medians across the attributes was of the order of .97.

Reliability of Ratings

Coefficients of reliability of the attribute ratings for the 76 attributes were computed across 182 of the 187 job elements. (Four job elements were not used in the process because they were "open-ended;" further, the job element dealing with licensing/certification was not included in this rating process.) Intraclass correlation coefficients were computed for the several ratings for each attribute. In turn, the Spearman-Brown prophesy formula was used to estimate the reliability of the mean attribute ratings across all raters for each attribute. (Although this formula applies to the reliability of the mean ratings, the median ratings were, for all practical purposes, essentially the same as the means.) The reliability coefficients of the pooled ratings for the various job elements generally were .80 and above. A frequency distribution of the pooled coefficients of reliability by class interval is given below:

Class interval of correlations	Type of attribute		Total
	Aptitudinal	Situational	
.90 and above	32	7	39
.85 to .89	13	5	17
.80 to .84	4	6	10
Below .80	1	9	10
	49	27	76

It can be seen that 39 of the 76 coefficients were .90 or above, and that 56 were .85 or above. The reliability of the aptitudinal attributes was generally higher than for those of a situational nature, as indicated by the fact that 44 of the 49 coefficients were .85 or above. The end result of this rating process consisted of the development of a matrix of attribute profiles for the job elements of the PAQ (Marquardt and McCormick, Report No. 1, June 1972).

DERIVATION OF JOB DIMENSIONS[2]

Principal component analyses were carried out with two sets of PAQ-based data. One set of such analyses was based on the actual analyses of jobs with the PAQ. The resulting job dimensions will be referred to as being based on job data. The other set of analyses was based on the attribute profile data described above, and will be so referred to. The components resulting from the various component analyses are referred to as job dimensions.

Job Dimensions Based on Job Data

Several sets of principal component analyses were based on analyses of jobs with the PAQ.

Job sample. The PAQ analyses used in the component analyses of job data were drawn from a pool of approximately 8,000 analyses that have been carried out by approximately 125 organizations that had used the PAQ for some operational purpose, or that prepared the PAQs specifically for use in the research project. For the purpose of the component analyses, a sample of 3700 PAQ analyses was drawn to be reasonably representative of labor force employment in the United States in the occupational categories of the Dictionary of Occupational Titles. Although the distribution of jobs in the sample tended to approximate the occupational distribution of the labor force by major occupational category, there were certain categories that were somewhat under-represented and others that were somewhat over-represented. These differences in part were dictated because of the types of jobs included within the total pool of 8,000.

Component analyses carried out. Seven of the principal component abalyses were based on data for the job elements within each of the six divisions of the PAQ. For the first five divisions a separate analysis was carried out with the job elements within each of those divisions. In the case of the sixth division (other job characteristics) two separate analyses were carried out, one for each of two sub-sets of the job elements in this division. The job elements in this division consisted of two types. Nineteen of these were rated with 5- or 6-point rating scales (such as used in the analysis of job elements in the previous divisions). The other fifteen job elements in this division were of a dichotomous nature, in that each job element was considered as applying, or as not applying, to a given job. These job elements included those dealing with the type of apparel worn (such as business suit or dress) and with work schedule factors (such as regular hours versus variable shift work). These seven analyses are referred to as "divisional" analyses. The eighth analysis was carried out with 168 of the job

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[2] This section is based largely on a report by Marquardt and McCormick (Report No. 2, Sept. 1973).

elements pooled together. (The elements for which the dichotomous scale and those of a "write-in" nature were not included.) This analysis is referred to as an overall or general (G) analysis.

Method of analysis. All of the divisional analyses consisted of a principal components analysis of the data in the intercorrelation matrix of PAQ items, including a varimax rotation of the matrix in step-wise fashion. The analyses were performed with 1.0 entered in the main diagonals of intercorrelation matrices, with the restriction that the extraction of components terminate when the eigenvalues became less than 1.0. An iterative rotation procedure was used in connection with the analyses, and the number of components chosen for use was not always the total number extracted. Essentially the same procedures were followed in connection with the overall or general principle components analysis except that in this case a somewhat arbitrary limit of fifteen components was imposed.

Results. A listing of the titles of the components (called job dimensions) is given in Table 1 in the left hand column (data on the loadings of the job elements of the different dimensions and interpretations are included in Report No. 4 by Marquardt and McCormick.) The amount of variance accounted for by the dimensions in the various analyses ranged from 56 to 63%.

Job Dimensions Based on Attribute Profile Data

As indicated earlier, the basic data for the principal components analyses of the attribute data consisted of the attribute profiles of the job elements of the PAQ, these profiles being the median values of the ratings of the relevance of the individual attributes to the job elements. In the various analyses carried out, five of the attributes were excluded because of low reliability of the ratings for those attributes (the cutoff for exclusion was R = .75). Certain of the PAQ job elements were excluded, in particular: items 188-194 (dealing with pay/income); and four "write-in" elements (44, 60, 127, and 181); and one dealing with licensing/certification (item 160). Thus, the analyses were based on 71 attributes and 182 job elements.

Types of analyses. The principal components analyses of these data were carried out with both R-type and with Q-type procedures. In the case of the R-type analyses the correlation matrix used consisted of correlations of the attribute ratings of the different attributes across all 182 job elements. In the case of the Q-type analyses the matrix consisted of correlations between and among the job elements of the PAQ across the ratings of 71 attributes. A summary of the analyses carried out is given below:

R-type analyses: Three analyses were carried out, one consisting of all 71 attributes, and the other two consisting separately of the aptitudinal attributes and of the situational attributes.

Q-type analyses: Six analyses were carried out, one for the job element attribute profiles of the job elements within each of the six divisions of the PAQ.

Method. The same procedures were followed in the principal components analyses of the attribute profile data as in the case of the job data reported above.

Results. The results of the R-type analyses are not reported here (see Marquardt and McCormick, Report No. 2, September 1973). The job dimensions resulting from the six Q-type analyses of the job elements of the six divisions of the PAQ are given in Table[1], along with the dimensions resulting from the principal components analyses of the job data. The 23 dimensions that resulted accounted for a large proportion of variance, the percents ranging from 81-88% for the analyses of the six divisions.

Discussion

In general terms the job dimensions derived from the component analyses of the two sets of PAQ-based data account for a fairly substantial proportion of the variance, especially in the case of those based on the attribute profile data. Further, in the case of at least many of the divisions, their content (as reflected by the loadings of the job elements on them) seems to make rational sense. In addition, many of the dimensions in this study approximate very closely, or are reasonably comparable with, those extracted previously with a smaller sample of jobs (Jeanneret and McCormick, Report No. 2, June 1969). These indications, along with the fact that the present sample was of fairly substantial size (3700 jobs) seem collectively to suggest that the job dimensions reported do in fact represent reasonably stable and meaningful dimensions of human work. It should be noted that the basic data on which the two sets of job dimensions shown in Table 1 are based were different. In the case of the job data the dimensions can be interpreted to reflect the extent to which the job elements tend to occur in combination as they actually exist in jobs, whereas in the case of the attribute profile data the dimensions can be interpreted as reflecting the extent to which different groupings of PAQ job elements have similar (rated) attribute requirements. Despite the fact that there are then distinct differences between the nature of the data on which the dimensions were based, it is still interesting to note that there are at least moderate parallels in the dimensions resulting from these two sets of data.

It should be noted that the job dimensions listed for any given division of the PAQ are not set in juxtaposition to each other in terms of similarity, but a scanning of the titles of the dimensions within at least certain of the divisions will reveal certain dimensions in both sets that do have reasonable similarity in terms of their content. (More specific comparisons could be made by examinations of the loadings of the job elements as reported in the two technical reports in question.)

Table 1

Summary of Job Dimension Titles[a]

Job Dimensions Based on Job Data	Job Dimensions Based on Attribute Profile Data
Division 1: Information Input	
J1-1 Percpetual Interpretation	A1-1 Visual Input from Devices/Materials
J1-2 Evaluation of Sensory Input	A1-2 Evaluation of Visual Input
J1-3 Visual Input from Devices/Materials	A1-3 Percpetual Input from Processes/Events
J1-4 Input from Representational Sources	A1-4 Verbal/Auditory Input/Interpretation
J1-5 Environmental Awareness	A1-5 Non-Visual Input
Division 2: Mental Processes	
J2-6 Decision Making	A2-6 Use of Job-Related Knowledge
J2-7 Information Processing	A2-7 Information Processing
Division 3: Work Output	
J3-8 Manual/Control Activities	A3-8 Manual Control/Coordination Activities
J3-9 Physical Coordination in Control/Related Activities	A3-9 Control/Equipment Operation
J3-1o General Body Activity versus Sedentary Activities	A3-10 General Body/Handling Activities
J3-11 Manipulating/Handling Activities	A3-11 Use of Foot Controls
J3-12 Adjusting/Operating Machines/Equipment	
J3-13 Skilled/Technical Activities	
J3-14 Use of Miscellaneous Equipment/Devices	
Division 4: Relationships with Other Persons	
J4-15 Interchange of Ideas/Judgments/ Related Information	A4-12 Interpersonal Communications
J4-16 Supervisory/Staff Activities	A4-13 Signal/Code Communications
J4-17 Public/Related Personal Contact	A4-14 Serving/Entertaining
J4-18 Communicating Instructions/Directions/Related Job Information	
J4-19 General Personal Contact	
J4-20 Job-Related Communications	

Table 1 (cont.)

Job Dimensions Based on Job Data		Job Dimensions Based on Attribute Profile Data	
	Division 5: Job Context		
J5-21	Potentially Stressful/Unpleasant Environment	A5-15	Unpleasant Physical Environment
J5-22	Potentially Hazardous Job Situations	A5-16	Personally Demanding Situations
J5-23	Personally Demanding Situations	A5-17	Hazardous Physical Environment
	Division 6: Other Job Characteristics		
J6-24	Attentive Job Demands	A6-18	Work Schedule I
J6-25	Vigilant/Discriminating Work Activities	A6-19	Job Responsibility
J6-26	Structured versus Unstructured Work Activities	A6-20	Routing/Repetitive Work Activities
J6-27	Regular versus Irregular Work Schedule	A6-21	Attentive/Discriminating Work Demands
J6-28	Work/Protective versus Business Clothing	A6-22	Work Attire
J6-29	Specific versus Non-Specific Clothing	A6-23	Work Schedule II
J6-30	Continuity of Work Load		
J6-31	Unnamed		

[a]The dimensions based on job data and on attribute profile data are arranged by PAQ division in parallel columns for comparative purposes. Within any given division there may be dimensions based on the two sources which may be identical, or nearly so. However, the ordering and numbering of dimensions within each division is not intended to reflect corresponding dimensions.

It would seem that the general results of these component analyses (as reflected by the job dimensions that were identified) offer substantial promise as the basis for the quantification of job data that might serve a variety of practical purposes.

Identification of Job Dimensions

The identification scheme for the various dimensions is described in detail elsewhere (Marquardt and McCormick, Report No. 2, September 1973). Very briefly, however, the identification system is characterized by the following features:

First letter: J stands for dimensions based on job data
A stands for dimensions based on attribute profile data

Second character: Identification of the division of the PAQ (ranging from one to six); in the case of dimensions based on the overall or general analyses letter G (standing for "general") is used.

Third element: Identification number of the job dimension within the basic set (these run consecutively from 1 for the dimensions of the separate divisional analyses).

JOB COMPONENT VALIDITY BASED ON PAQ DATA[3]

The conventional procedure that is followed in the validation of tests for personnel selection purposes consists of the administration of one or more tests to a sample of present job incumbents or job candidates, the development of a criterion (usually a measure of job success) for these individuals, and the statistical analysis of the relationship between scores on the individual tests and the job performance criterion values. This typical procedure is of course a rather time consuming one, and frequently there are a number of problems associated with it, such as the following: the time and effort taken to carry out such analyses in each and every situation; the small number of incumbents on some jobs (this would preclude the use of this procedure); the restriction on the range of test scores or criterion values (especially in the case of the use of present job incumbents); and the possible limited reliability and validity of the criterion measures used. These and other factors have led to efforts to develop some generalized procedures that could be used for the identification of tests that would be valid for the selection of individuals for specific jobs, thus hopefully precluding the necessity for conventional test validation procedures. In general terms, since the "validity" of tests for personnel selection purposes is essentially rooted in the characteristics of jobs, it would seem that any generalized approach to the identification of tests for use in personnel selection should be predicated

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[3] This section is based primarily on a report by Marquardt and McCormick (Report No. 5, July 1974).

upon systematic consideration of the content of jobs. It would seem that insofar as various jobs have a given characteristic in common, the human qualities required for the performance of the activity in question should be the same.

In the long run, the optimum basis for a "generalized" procedure for identifying tests for personnel selection would be to determine, for any given job component (that is, any given job characteristic), the paricular test or tests that would be valid for the selection of people to perform the activity implied by that component. The development of such a data base would involve an effort of major proportions. In the absence of such a set of data, various "indirect" procedures presumably would be necessary. This study represents at least one approach to the development of a systematic procedure for the selection of tests for individual jobs (as based on systematic job analysis data) that presumably would be generally valid for personnel selection purposes.

Since such a procedure would be predicated upon the analysis of jobs in terms of each of a number of specific characteristics, it is here referred to as the concept of job component validity.

Data Used in Present Study

In the present study job dimension scores based on the various sets of job dimensions were used to characterize the jobs in the sample, in particular the following:

30 divisional job dimensions based on job data
14 general job dimensions based on job data
23 job dimensions based on attribute profiles

The criterion data consisted of test data for job incumbents on each of the jobs in the sample used, in particular the test data being based on the nine tests of the General Aptitude Test Battery (GATB) of the United States Training and Employment Service (USTES), (United States Department of Labor, 1970). The USTES has published normative test data for these tests for incumbents on each of approximately 450 jobs. The published test data for each job includes the the mean, the standard deviation, and in most instances validity coefficients for some or all of the nine GATB tests. Most of the jobs for which data are published had fifty or more incumbents.

For each job included in the sample, three criterion measures were used, as follows: the mean test scores of job incumbents; "potential cutoff scores" (which consisted of the test score one standard deviation below the mean of the incumbents on the job in question); and coefficients of validity. Such data were used for each of the nine tests independently.

The rationale for the use of mean test scores as criteria of the "importance" of tests for individual jobs is based on the assumption that people tend to gravitate into jobs that are compatible with their

own ability level. Thus, to the extent to which this assumption is valid, jobs for which incumbents have generally high mean test scores presumably would require more of the quality measured by the test than jobs for which the mean test scores of incumbents are low. The second criterion (based on the same assumption) was used since it might more nearly approximate conventional test cutoff scores in practical situations. The third criterion, the coefficient of validity tests, would be based on the assumption that such coefficients imply the amount of variance in the criterion that is associated with a test.

Sample of Jobs

The sample of jobs included in this phase of the study was drawn from the sample of 3700 jobs mentioned above. The cases drawn from that larger sample were those which "matched" jobs for which GATB test data were available, the matching being based on code numbers of the Dictionary of Occupational Titles (D.O.T.). Actually there were 658 PAQs for jobs which matched 141 different jobs for which the GATB test data were available. However, some of the 141 jobs were combined in the presentation of the GATB normative data, and in effect, these 141 jobs matched 125 sets of GATB norms. (When two or more jobs were combined for the presentation of GATB norms, it is presumed that the jobs were considered to be reasonably comparable in terms of their basic characteristics.) In general terms, then, data on 658 separate PAQ analyses were used in this phase of the study, the positions represented by these analyses being "matched" with 125 test data norms for jobs that represented 141 jobs.

Analyses Performed

The three sets of job dimension scores were then used as predictors for the 658 PAQ analyses in a series of multiple regression analyses, using each of the three criteria mentioned above as related to the corresponding 125 sets of GATB normative data. Such analyses were carried out separately for the three criteria for each of the nine GATB tests. A double cross-validation procedure was used, with the sample being split randomly into two halves (A and B). Thus, a total of 243 separate multiple regression analyses were performed: nine tests x three criteria x three samples (A, B, and combined) x three sets of job dimension scores = 243 analyses. A step-wise multiple regression procedure was used for all of these analyses.

In the cross-validation procedure, the regression equations based on the analysis of the predictors of the criterion for one sample (in this case A or B) were then applied to the cases in the other sample (in this case B and A, respectively). The predicted values were then correlated with the criterion values to produce cross-validation coefficients.

Results

Some of the results are summarized in Table 2. In particular that table presents a summary of the croos-validation coefficients of the job dimension scores with the three criteria that were based on scores on the nine GATB tests of the incumbents on the "matched" jobs. Since there were nine tests and two samples there were eighteen coefficients, so the range of values shown in that table is for these eighteen coefficients. These are given separately for the three criteria.

In most instances the multiple correlations of job dimension scores are based on combinations of eight or nine job dimensions.

Table 2

Summary of Cross-Validation Coefficients* of Job Dimension Scores with Three Job Criteria Based on Scores on Nine Tests of Incumbents on Various Jobs

Type of job dimension	Criterion		
	Mean test scores	Potential cut-off scores	Validity coefficients
	Range Mdn	Range Mdn	Range Mdn
Based on job data			
Divisional job dimensions	46-76 71	42-77 73	26-44 39
General job dimensions	16-75 71	18-76 71	03-38 32
Based on attribute profile data	47-45 71	44-77 69	23-38 32

*Decimal points omitted for correlation coefficients

Discussion

By and large, these results are essentially of the same order of magnitude as reported in the previous study by McCormick, Jeanneret, and Mecham (Report No. 6, June 1969), although the results of the present study tend to be a shade lower than in the previous study. In reviewing the results certain general observations might be made. In the first place, the results relating to the types of job dimensions used (those based on job data versus those based on attribute profile data) are reasonably comparable, although those based on job data tend to be a bit higher, particularly as reflected by the cross-validation coefficients shown in Table 2. Further, the results for the criterion of potential cutoff scores seem to be roughly the same as for those based on the criterion of mean test scores. This finding is particularly interesting since, in a practical situation, one might wish to use potential cutoff scores as the operationally more useful criterion. As in the case of the previous study, the prediction of the validity coefficients was considerably lower than in the case of the other criteria. This is perhaps in part a function of the several factors mentioned earlier that influence validity coefficients. The results also indicate that the prediction of the test-related criteria for the cognitive tests was generally better than for the psychomotor tests. In general, it would seem that the use of a structured job analysis procedure (such as that represented by the PAQ) can serve as the basis for the establishment of job component validity of personnel tests strictly on the basis of job-based data, without the need for conventional test validation procedures in many situations.

JOB COMPONENT METHOD FOR ESTABLISHING COMPENSATION RATES[4]

The basic objectives of conventional job evaluation programs are those of ordering jobs within organizations along a scale that reflects their relative similarities and differences in terms of characteristics that presumably are relevant to the establishment of compensation rates, and the establishment of the general wage or salary level within an organization in terms of some policy-based relationship to corresponding rates in the labor market. In the case of most job evaluation systems the actual job evaluation process is based on the judgements or evaluations of individuals regarding various characteristics of jobs as these are implied by conventional job descriptions.

It would seem that, since the evaluations used in such procedures are predicated essentially upon job characteristics, it might be possible to use job data based on a structured job analysis procedure as the direct basis for the derivation of compensation indexes that, in turn, could be used for establishing compensation rates for jobs. One could view the process of prediction of compensation rates for individual jobs in much the same manner as previously discussed in connection with the establishment of the job component validity of jobs, except that in this instance one would use a criterion of actual going rates of jobs. Job dimension scores based on an instrument such as the PAQ could be used as the predictors.

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[4] This section is based primarily on a technical report by McCormick, DeNisi, and Marquardt (Report No. 6, September, 1974).

This study consisted essentially of this procedure, and represents, in effect, an extension of a previous study that also was based on this procedure by Mecham and McCormick (Report No. 4, June 1969). The present study, however, was based on a much larger sample of jobs, and involved the use of Form B of the Position Analysis Questionnaire (PAQ), whereas the previous study was based on Form A of the PAQ.

Sample of Jobs

The sample of jobs used was drawn from the sample of 3700 jobs that had been used previously in the component analysis of job elements of the PAQ. In particular, the jobs in that sample that were used in this study were the ones for which compensation rates had been furnished at the time the analyses were completed. Two types of adjustments were made to some of the compensation data available. In the first place, all the compensation data were converted to a common metric, namely dollars per month. Compensation reported for other time periods was converted to this metric. In the second place, compensation rates reported during 1970, and 1972 were adjusted upwards to 1973 levels. In the case of some organizations it was possible to obtain 1973 rates for jobs that had been analyzed previously. In the cases in which this was not feasible an upward adjustment was used that was based on data from various Federal government reports that reflected average increase in earnings during these years. Of the 3700 jobs in the base sample, compensation rates were available for 2762. Of these, 2688 were used in the study, in particular those with compensation values ranging from $326.00 to $1,450.00. This sample was ordered from high to low in terms of compensation rates, and alternate jobs were placed in two subsamples of 1344 jobs each (A and B) for use in the cross-validation procedure.

PAQ-Based Data Used as Predictors

Three types of PAQ-based data were used as possible predictors of the criterion values for compensation rates per month. Two of these types of data consisted of job dimension scores for the job dimensions previously derived on the basis of job data, one of these consisting of the 30 "divisional" job dimensions, and the other set consisting of the 14 "general" (G) job dimensions previously described. The third set of PAQ-based predictors consisted of the ratings for the jobs on 99 of the job elements. Only 99 of the 187 job elements were used in order to limit the ratio of the number of predictors to the humber of jobs. The job elements not included were those with the lowest correlations with compensation rates.

A step-wise regression analysis was carried out for each sample (A,B and A+B), and a regression equation was derived for each sample based on each of the three sets of predictors (individual PAQ items, divisional job dimension scores, and overall job dimension scores). The regression equation for a given predictor based on sample A was then applied to sample B and vice versa (the cross-validation portion of the procedures), to determine the amount of shrinkage in predictability from subsample to subsample.

As a final step, the data for the total sample (A+B) was used in a comparison of predicted compensation rates (as determined from all three sets of predictors) and actual compensation rates, in order to determine the residual or lack of predictability for each set of predictors.

Results

A summary of the results is given in Table 3, that table showing, for each of the three sets of predictors, the multiple correlations for the two subsamples and the combined sample, and the cross-validated coefficients of the three sets of compensation rates.

Table 3

Multiple Correlations and Cross-Validation Coefficients of Regression Equations Based on Job Data of the PAQ Used to Predict Compensation Rates

Type of Predictor	A	B	A+B	A on B	B on A
Overall Dimensions	.65	.65	.65	.64	.64
Divisional Dimensions	.70	.69	.69	.67	.68
Raw Data	.70	.69	.68	.64	.64

Discussion

The general level of predictability of the PAQ-based data resulting from this study was somewhat lower than the corresponding predictability of a previous study by Mecham and McCormick (Report No. 4, June 1969). This lower level of predictability probably can be attributed in large part to the fact that the compensation data were obtained over a period of four years (1970, 1971, 1972, and 1973) with upward adjustments being made to the data collected over the first three years. Three adjustments were made on the basis of general indexes of increases in wages and salaries during those years. It is believed that the volatile nature of the economy of that time may have resulted in substantial mis-alignment of some of the jobs in terms of relative positions along a compensation scale to the degree that predictability was somewhat reduced. A second possible explanation may be based in the fact that the data for this study covers a very wide range of industries and geographic areas, with no correction made for possible differentials in earnings for these factors. Since industrial and geographical factors are generally considered to have some bearing on compensation rates, special analyses were carried out for three companies for which a large number of PAQ's were available.

In each of these instances the regression equation based on the dimensions for the combined sample was applied separately to the PAQ's for the jobs in each of these three companies. The resulting predicted compensation indexes were then correlated with the actual compensation rates for the jobs within each organization. The resulting correlations were

The predicted compensation rates in the case of all three types of predictors tended to over-predict the actual rates of pay of jobs with low levels of compensation, and to under-predict the actual rates of pay of jobs with higher levels of compensation.

Although the results of the analyses for the entire sample of jobs and the two subsamples were relatively moderate, the analyses of the data for these three companies tended to indicate quite strongly that job compensation values can be estimated with reasonable adequacy by the use of structured job analysis instrument such as the Position Analysis Questionnaire, within the framework of individual organizations.

THE ANALYSIS OF RATES OF NAVAL COMPENSATION[5]

The results of previous research with the PAQ as the possible basis for the establishment of compensation rates suggest the possibility that structured job analysis procedures might also have some utility in connection with the establishment of rates of compensation for Naval personnel. The present study represents a probing effort in this direction, with two purposes in mind, namely that of relating naval compensation for incumbents of naval billets to the compensation for civilian jobs with similar characteristics, and that of assessing the potential utility of the PAQ for allocating naval billets to pay rates.

Position Analysis Questionnaire (PAQ): Navy Edition

A naval version of the PAQ was developed for this study, this being essentially a modification of Form B of the PAQ. The modification consisted largely of the substitution of naval terminology in defining and illustrating the job elements.

Samples of Naval Billets

Two samples of naval billets were used in the study, the first consisting of 607 enlisted billets on board three aircraft carriers and in six air squadrons, and the second consisting of 249 officer billets of various types. The analyses of most of the enlisted billets were performed by project personnel with a few being done by military personnel hired from the ships' companies. The analyses of the billets in the officer sample were performed by the officers themselves.

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[5] This section is based on a report by Harris and McCormick (Report No. 3, September 1973).

Comparison of Naval and Civilian Compensation

One of the purposes of this study was that of comparing the compensation for incumbents of naval billets with that for civilian jobs with similar characteristics, as these characteristics were reflected by job dimension scores of the PAQ. The basic approach of this study was that of using the PAQ analyses of the naval billets as the basis for the estimation of compensation rates that would be applicable for civilian jobs with similar characteristics. This was done by applying to the naval billets the same regression equation that had been found to be most predictive of rates of pay for civilian jobs.

Bases of computation of naval compensation. The compensation of naval personnel is admittedly difficult to estimate, by reason of the fact that there are certain types of fringe "benefits" that have some monetary value. For certain purposes in this study three types of compensation indexes were used, these being: basic compensation (based on the rate or rank and cumulative years of service of the incumbent); direct naval compensation (including what might be thought of as "money equivalents" such as quarters allowance, subsistance allowance, sea duty pay, and estimated tax advantage); and total naval compensation (consisting of direct naval compensation plus estimates of the value of retirement, medical care, commissary privileges, life insurance benefits, etc.).

A number of the allowances and benefits that have "money equivalents" are not directly related to the requirements or responsibilities of the billets of the incumbents, but rather are determined by such factors as dependency status of the incumbents, and their plans to remain or not remain in the service (which would influence the applicability of retirement benefits). Without going into details, the three different pay assumptions were estimated for the personnel in each of the billets, these assumptions generally being those which would reflect the possible range of naval compensation, as follows: A (high); B (intermediate); and C (low).

Correlations between civilian and naval compensation. Correlations were computed between each of the three types of naval compensations (basic, direct, and total) and the predicted civilian job values for jobs with similar characteristics. This was done separately for the enlisted sample, the officer sample, and the combined sample, for each of the three sets of assumptions mentioned above (A, B, and C). In general terms, the correlations for all three assumptions were approximately the same, the correlations in the case of the enlisted sample ranging from .63 to .65, for the officers sample from .28 to .29, and for the combined sample .83 to .84. Clearly, the compensation for officer billets is much less related to rates of compensation for civilian jobs with corresponding characteristics than in the case of enlisted billets.

Comparison of mean naval and civilian compensation rates. A comparison was made for personnel in each pay grade between the annual direct naval compensation rates under "high" (A) and "low" (C) pay assumptions with the mean annual civilian job values estimated on the basis

of the PAQ analyses of the billets. In general terms, the naval compensation, even under the high (A) assumption, was rather systematically lower than the corresponding civilian job values in the case of the enlisted pay grades. In the case of officers in the lower officer pay grades (Ensign and Lieutenant Junior Grade) the naval compensation rates were below the corresponding civilian job values, but in the case of officers in the higher pay grades (Commander and Captain) the naval compensation rates were above the corresponding civilian job values. However, it should be noted that the lower and higher pay grades are represented by very few cases, so these data have to be considered with reservations.

Discussion. At least in the case of enlisted billets, it appears that a structured job analysis procedure such as the PAQ can serve as the basis for comparing the compensation of naval personnel with that of civilian personnel engaged in jobs with corresponding characteristics. The results of the comparison made in this study indicated a systematically higher level of compensation for civilian jobs than for corresponding naval billets, even under a "high" (A) assumption regarding the fringe benefits that might accrue to naval personnel.

PAQ Data for Establishing Pay Grades for Naval Billets

The second objective of this study was that of exploring the possible use of a structured job analysis procedure such as the PAQ as the basis for the establishment of pay grades for naval billets.

Procedures and results. In this phase of the study three methods were used in deriving predicted compensation values for the naval billets as based on the PAQ analyses of the billets. The method reported here consisted of the use of regression equations based on job dimensions resulting from principal components analyses of the PAQ data from the naval billets included in the study. The predicted compensation values based on these regression equations were then correlated with the "total" compensation for personnel in the respective billets, using the "high" (A) pay assumption discussed before. The resulting correlations are given below for the enlisted, officer, and combined samples:

	Obtained Correlation	Shrunken Correlation
Enlisted sample (n = 459)	.80	.76
Officer sample (n = 247)	.52	.37
Combined sample (n = 706)	.90	.89

Discussion. It is apparent from these results that the PAQ would be potentially more useful as the basis for determining the appropriate pay grades for enlisted billets than for officer billets. If a structured job analysis procedure were to be used as the basis for allocating officer billets to appropriate pay grades it would appear that the procedure should provide for more adequate differentiations of the job activities between and among varying levels of supervisory, management, and command positions.

JOB AND PERSONAL FACTORS AS RELATED TO JOB SATISFACTION[6]

This phase of the project was directed toward the analysis of certain job and personal variables as related to job satisfaction. In particular, it was the intent to determine the extent to which job characteristics as reflected by job dimension scores of the PAQ as well as certain interest and attitude variables, contributed to the variance of job satisfaction responses.

Sample

The study was carried out with 408 employees on 29 jobs in two telephone companies.

Data Collected

The data collected for the study included the following:

1. A PAQ. For most of the jobs three independent PAQ's were prepared, and the average of these was used as the description of the job. Job dimension scores were obtained or derived for the 30 divisional job dimensions.

2. Interests of job incumbents. The interests of job incumbents were measured with the Job Activity Preference Questionnaire (JAPQ) which is an interest inventory that parallels the PAQ. On the basis of responses to this it is possible to derive job dimension scores that reflect the interests of the individuals on the 30 job dimensions.

3. A scale of response disposition. This is basically a scale of optimism-pessimism developed by Beck (1973) intended to tap the "response disposition" of individuals toward reacting positively or negatively, or optimistically or pessimistically, to things in general. A few additional items were added to this scale.

4. Job Description Index (JDI). The JDI was developed by Patricia Smith (Smith, Kendall, and Hulin, 1969), and provides for individuals to "describe" five aspects of their jobs, as follows: work, supervision, co-workers, pay, and promotions. There is also provision for deriving a total score based on responses to all five sections.

Analyses

Separate analyses were carried out for incumbents of the two companies. In each case, analyses were carried out between the several

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[6] This section is based on a report by Calitz, Hilaael, McCormick, and Peters (Report No. 8, October 1973).

predictor variables, separately and in certain combinations, as related to "total" job satisfaction and to satisfaction with the "work itself" (one of the sub-scales of the JDI). The predictors included the following:

1. PAQ job dimension scores.

2. JAPQ job dimension scores.

3. A d^2 index of the "match" between the interest profile of each individual and the job dimension profile of his or her job.

4. A response disposition score for each person.

5. Scores derived from the PAQ on each of the following four factors:

   (a) module (work that forms a reasonably complete "whole" or "unit").
   (b) feedback
   (c) control (by the incumbent over his job).
   (d) opportunity to use one's skill and education.

   These aspects of jobs have been hypothesized by Ford (1969) as being related to job satisfaction. Each of these was scored on the basis of a certain set of job elements of the PAQ that were judged to reflect or represent the factor in question.

6. Certain items of personal data such as age, sex, and time with the company.

Results

By and large the results indicated that the dominant factors associated with "total" satisfaction and with satisfaction with one's "work" were the job characteristics (specifically certain combinations of job dimension scores based on the PAQ), and job interests as reflected by the combination of certain job dimensions based on responses to the JAPQ. In one of the companies, for example, the following correlations were obtained (these are not adjusted for shrinkage):

Factor	Correlation with "total" satisfaction	Correlation with "work" satisfaction
Job characteristics (PAQ job dimensions)	.48	.70
Interests (JAPQ)	.50	.52
"Match" between job and interests (d^2)	-.18	-.20
Response disposition	-.31	-.37
Combination of above	.62	.76

The negative correlations above occur because of the method of scoring. They are in the "expected" directions.

Discussion

The rather substantial multiple correlations of combinations of job dimension scores with total satisfaction and with satisfaction with one's work, generally support the hypothesis that job characteristics do play a significant role in influencing job satisfaction. However, the correlation between the d^2 index (the "match" between profile of job interests and the profile of the job), although rather modest, still indicates that there are differential attitudes among individuals toward various job activities. The rather substantial correlations between interests (as measured by the JAPQ) and job satsifaction seems to imply that certain patterns of interests in job activities generally are associated with favorable attitudes towards one's job, very possibly in a cause and effect manner. In fact, it is very possible that expressions of satisfaction with one's job may, in part, be simply a reflection of one's favorable disposition toward job activities in general. This "predisposition" toward reacting favorably to job situations is somewhat supported by the correlation of the response disposition scale with job satisfaction responses. In general terms the overall level of correlation with job satisfaction based on the predictors was of rather substantial proportions.

DEVELOPMENT OF JOB FAMILIES[7]

The grouping into job families of jobs with reasonably common characteristics could serve various purposes, such as personnel selection, vocational counseling, the establishment of compensation rates, etc. The data obtained with the PAQ were used as the basis for two job-clustering studies, toward the end of developing job families that might serve various purposes.

BC-TRY Job Clusters

One study involved the use of the total sample of 3700 jobs mentioned before. In this study, the job data used consisted of scores on the 14 overall or general (G) job dimensions. The clustering procedure used was the BC-TRY procedure developed by Tryon and Bailey (1970). This analysis resulted in 33 clusters.

CODAP Job Clusters

The other analysis was carried out with 21 of the 30 "divisional" job dimensions, the input for each job consisting of scores on these dimensions. A sub-sample of 800 jobs was used in this study. A hierarchical grouping procedure was used, the index of similarity between the pairs of jobs being a d^2 value. The computer program used was a modification of the CODAP program (Comprehensive Occupational Data Analysis Program) which was developed by the United States Air Force. The clustering that was considered to be most suitable consisted of 42 clusters.

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[7] This section is based on a report by DeNisi and McCormick (Report No. 7, November, 1974.

Discussion

Both the BC-TRY and CODAP clusters are represented in the basic report by DeNisi and McCormick (Report No. 7). One comparison of the clusters formed by the two programs consisted of a comparison of the standard deviations and homogeneity indexes of the job dimension scores of the jobs within the clusters. This comparison indicated quite clearly that the clusters based on the BC-TRY program were more homegeneous than those derived from the CODAP program. However, this difference could be in part the consequence of the nature of the input data (i.e., the general (G) dimensions versus the "divisional" dimensions), or of the program used. Further, it could be in part a function of the statistics used to reflect the degree of similarity. The BC-TRY procedure involves the use of coefficients of correlation, while a d^2 index was used with the CODAP program. In this regard, subsequent to the execution of the CODAP program Dr. William J. Cunningham of North Carolina State University (under whose direction the CODAP program was executed) made a comparison of various indexes of similarity for use with the CODAP program. On the basis of this he expressed the opinion that other indexes seem to be more appropriate in this frame of reference than the d^2 index. Thus, the somewhat less clear-cut clusters resulting from the CODAP program might be in part attributable to the use of the d^2 index.

DISCUSSION

The experience with the Position Analysis Questionnaire in this study seems definitely to support the indications from previous research that the use of a structured job analysis procedure can provide job-related information that can have a variety of possible practical applications. There are certainly very strong indications that such a procedure can be used as the basis for the establishment of aptitude requirements for jobs. In addition, it appears that such a procedure could be used as the basis for the estimation of compensation rates for jobs; however, it is probable that at the present time such procedures could best be utilized within the framework of individual contexts (such as within individual organizations) since it appears that the geographical and industrial variability in compensation rates might somewhat limit the general utility of this approach on an across-the-board basis. It also appears that a structured job analysis procedure could be used as the basis for the clustering of jobs into job families or clusters in terms of similarities of profiles of job characteristics. In this regard, however, it is probable that further experimentation in the formation of job clusters would be in order, before it might be possible to identify a "master" set of job clusters that might have wide-spread utility. In particular, it is probable that further research should deal both with the determination of the appropriate "units" of job-related data that should be used for this purpose, and relating to the statistical procedures that would be optimum to use in a clustering approach. Ultimately, it seems that the establishment of a relatively definitive set of job clusters could serve a variety of purposes in personal management. For example, given a set of aptitude profiles for the jobs within any given cluster, it might be possible to allocate the job to the job cluster that it best matches, and apply that job to the set of aptitude requirements for the cluster.

Further, it is probable that a structured job analysis procedure could serve a variety of research purposes. In this particular study, for example, the PAQ was used as the basis for quantifying job characteristics of jobs in order to determine the relationship between such characteristics and job satisfaction. (This is probably the most definitive study of this type available.) Other possible research applications could also be considered in which it would be useful to have quantitative measures of jobs as independent variables.

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